**Claims**

1. An optical scanning device characterised in that it comprises:

a platform,

a mirror provided on said platform to reflect an optical beam incident on said mirror,

a pivot about which said platform is able to pivot,

at least first piezoelectric actuator means to act on said platform to pivot said platform about said pivot in a first direction,

at least first resilient means to bias said platform about said pivot in a second direction opposed to said first direction,

wherein said first piezoelectric actuator means acts on said platform at a location in proximity to said pivot, to pivot said platform such that the angle at which said beam is reflected by said mirror is altered to alter the path of the reflected beam to thereby scan the reflected beam in a first plane over a surface.

2. An optical scanning device according to claim 1, characterised in that it further comprises

second piezoelectric actuator means to act on said platform to pivot said platform about said pivot in a third direction,

second resilient means to bias said platform about said pivot in a fourth direction opposed to said third direction, and

wherein said second piezoelectric actuator means acts on said platform at a location in proximity to said pivot, to pivot said platform such that the angle at which said beam is reflected by said mirror is altered to alter the path of the reflected beam to thereby scan the reflected beam in a second plane over said surface, such that said reflected beam is scannable over said surface in two dimensions.

3. An optical scanning device characterised in that it comprises:

a platform,

a mirror provided on said platform to reflect an optical beam incident on said mirror,

a pivot about which said platform is able to pivot,

first piezoelectric actuator means to act on said platform to pivot said platform about said pivot in a first direction,

first resilient means to bias said platform about said pivot in a second direction opposed to said first direction,

second piezoelectric actuator means to act on said platform to pivot said platform about said pivot in a third direction, and

second resilient means to bias said platform about said pivot in a fourth direction opposed to said third direction,

wherein said first piezoelectric actuator means acts on said platform at a location in proximity to said pivot, to pivot said platform such that the angle at which said beam is reflected by said mirror is altered to alter the path of the reflected beam to thereby scan the reflected beam in a first plane over a surface, and said second piezoelectric actuator means acts on said platform at a location in proximity to said pivot, to pivot said platform such that the angle at which said beam is reflected by said mirror is altered to alter the path of the reflected beam to thereby scan the reflected beam in a second plane over said surface, such that said reflected beam is scannable over said surface in two dimensions.

4. An optical scanning device according to any one of the preceding claims, characterised in that a cap is provided over an end of said first piezoelectric actuator means that is located proximate said platform to limit sideways movement of said first piezoelectric actuator means proximate said platform.

5. An optical scanning device according to any one of the preceding claims, characterised in that a push-pull amplifier is provided to drive said first piezoelectric actuator means.

6. An optical scanning device according to any one of the preceding claims,

characterised in that said first piezoelectric actuator means acts on said platform to push said platform and said first resilient means is compressively resilient.

7. An optical scanning device according to any one of claims 1 to 5, characterised in that said first piezoelectric actuator means acts on said platform to push said platform and said first resilient means is expandably resilient.

8. An optical scanning device according to any one of claims 1 to 5, characterised in that said first piezoelectric actuator means acts on said platform to pull said platform and said first resilient means is compressively resilient.

9. An optical scanning device according to any one of claims 1 to 5, characterised in that said first piezoelectric actuator means acts on said platform to pull said platform and said first resilient means is expandably resilient.

10. An optical scanning device according to any one of claims 2 to 9, characterised in that a cap is provided over an end of said second piezoelectric actuator means that is located proximate said platform to limit sideways movement of said second piezoelectric actuator means proximate said platform.

11. An optical scanning device according to any one of claims 2 to 9, characterised in that a push-pull amplifier is provided to drive said second piezoelectric actuator means.

12. An optical scanning device according to any one of claims 2 to 9, characterised in that said second piezoelectric actuator means acts on said platform to push said platform and said second resilient means is compressively resilient.

13. An optical scanning device according to any one of claims 2 to 9, characterised in that said second piezoelectric actuator means acts on said platform to push said platform and said second resilient means is expandably resilient.

14. An optical scanning device according to any one of claims 2 to 9, characterised in that said second piezoelectric actuator means acts on said platform to pull said platform and said second resilient means is compressively resilient.

15. An optical scanning device according to any one of claims 2 to9, characterised in that said second piezoelectric actuator means acts on said platform to pull said platform and said second resilient means is expandably resilient.

16. An optical scanning device according to any one of the preceding claims, characterised in that said optical beam is a laser beam.

17. An optical scanning device according to any one of claims 2 to 16, characterised in that said first plane and said second plane are substantially mutually orthogonal.

18. An optical scanning apparatus characterised in that it comprises:

a first optical scanning device, and

a second optical scanning device,

said first optical scanning device comprising

a first platform

a first mirror provided on said first platform to reflect an optical beam incident on said first mirror,

a first pivot about which said first platform is able to pivot,

first piezoelectric actuator means to act on said first platform to pivot said first platform about said first pivot in a first direction, and

first resilient means to bias said first platform about said first pivot in a second direction opposed to said first direction, and

said second optical scanning device comprising

a second platform

a second mirror provided on said second platform to reflect the optical beam incident on said second mirror,

a second pivot about which said second platform is able to pivot,

second piezoelectric actuator means to act on said second platform to pivot said second platform about said second pivot in a third direction, and

second resilient means to bias said second platform about said second pivot in a fourth direction opposed to said third direction,

wherein said first piezoelectric actuator means acts on said first platform at a location in proximity to said first pivot to pivot said first platform such that the angle at which said beam is reflected by said first mirror is altered to alter the path of the reflected beam to thereby scan the reflected beam in a first plane, and said second optical scanning device is arranged such that said second mirror receives said beam reflected by said first mirror and said second piezoelectric actuator means acts on said second platform at a location in proximity to said second pivot to pivot said second platform such that the angle at which said beam is reflected by said second mirror is altered to alter the path of the reflected beam to thereby scan the reflected beam in a second plane, such that said reflected beam is scannable over said surface in two dimensions.

19. An optical scanning apparatus according to claim 18, characterised in that a cap is provided over an end of said first piezoelectric actuator means that is located proximate said first platform to limit sideways movement of said first piezoelectric actuator means proximate said first platform.

20. An optical scanning apparatus according to claim 18 or 19, characterised in that a first push-pull amplifier is provided to drive said first piezoelectric actuator means.

21. An optical scanning apparatus according to any one of claims 18 to 20, characterised in that said first piezoelectric actuator means acts on said first platform to push said first platform and said first resilient means is compressively resilient.

22. An optical scanning apparatus according to any one of claims 18 to 20, characterised in that said first piezoelectric actuator means acts on said first platform to push said first platform and said first resilient means is expandably resilient.

23. An optical scanning apparatus according to any one of claims 18 to 20,

characterised in that said first piezoelectric actuator means acts on said first platform to pull said first platform and said first resilient means is compressively resilient.

24. An optical scanning apparatus according to any one of claims 18 to 20, characterised in that said first piezoelectric actuator means acts on said first platform to pull said first platform and said first resilient means is expandably resilient.

25. An optical scanning apparatus according to any one of claims 18 to 24, characterised in that a cap is provided over an end of said second piezoelectric actuator means that is located proximate said second platform to limit sideways movement of said second piezoelectric actuator means proximate said second platform.

26. An optical scanning apparatus according to any one of claims 18 to 25, characterised in that a second push-pull amplifier is provided to drive said second piezoelectric actuator means.

27. An optical scanning apparatus according to any one of claims 18 to 26, characterised in that said second piezoelectric actuator means acts on said second platform to push said second platform and said second resilient means is compressively resilient.

28. An optical scanning apparatus according to any one of claims 18 to 26, characterised in that said second piezoelectric actuator means acts on said second platform to push said second platform and said second resilient means is expandably resilient.

29. An optical scanning apparatus according to any one of claims 18 to 26, characterised in that said second piezoelectric actuator means acts on said second platform to pull said second platform and said second resilient means is compressively resilient.

30. An optical scanning apparatus according to any one of claims 18 to 26, characterised in that said second piezoelectric actuator means acts on said second platform to pull said second platform and said second resilient means is expandably resilient.

31. An optical scanning apparatus according to any one of claims 18 to 30, characterised in that said optical beam is a laser beam.

32. An optical scanning apparatus according to any one of claims 18 to 31, characterised in that said first plane and said second plane are substantially mutually orthogonal.

33. A laser apparatus characterised in that it comprises:

a laser to emit an optical beam, and

an optical scanning device according to any one of claims 1 to 17,

wherein the reflected beam is scannable over the surface to perform material processing of said surface by the reflected beam and the optical path of the reflected beam from said optical scanning device to said surface is substantially one metre or more in length.

34. A laser apparatus characterised in that it comprises:

a laser to emit an optical beam, and

an optical scanning device comprising

a platform,

a mirror provided on said platform to reflect a said optical beam incident on said mirror,

a pivot about which said platform is able to pivot,

first piezoelectric actuator means to act on said platform to pivot said platform about said pivot in a first direction,

first resilient means to bias said platform about said pivot in a second direction opposed to said first direction,

second piezoelectric actuator means to act on said platform to pivot said platform about said pivot in a third direction,

second resilient means to bias said platform about said pivot in a fourth

direction opposed to said third direction,

wherein said first piezoelectric actuator means acts on said platform at a location in proximity to said pivot, to pivot said platform such that the angle at which said beam is reflected by said mirror is altered to alter the path of the reflected beam to thereby scan the reflected beam in a first plane and said second piezoelectric actuator means acts on said platform at a location in proximity to said pivot, to pivot said platform such that angle at which said beam is reflected by said mirror is altered to alter the path of the reflected beam to thereby scan the reflected beam in a second plane, such that said reflected beam is scannable over said surface in two dimensions to thereby scan the reflected beam over the surface to perform material processing of said surface by the reflected beam and the optical path of the reflected beam from said optical scanning device to said surface is substantially one metre or more in length.

35. A laser apparatus according to claim 33 or 34, characterised in that it further comprises a second mirror to reflect the reflected beam reflected by said mirror of said optical scanning device prior to said reflected beam being reflected to said surface.

36. A laser apparatus according to claim 35, characterised in that it further comprises a third mirror to receive the reflected beam from said second mirror and said third mirror is arranged to reflect said beam to said surface.

37. A laser apparatus according to any one of claims 33 to 36, characterised in that said laser apparatus is a refractive eye surgery laser apparatus, and the surface on which the material processing is performed by the reflected beam is the eye of a patient on which the refractive surgery is performed by the reflected beam.

39. A laser apparatus comprising:

a laser to emit an optical beam, and

an optical scanning apparatus according to any one of claims 18 to 32,

wherein the reflected beam is scannable over a surface to perform material processing of said surface by the reflected beam and the optical path of the

reflected beam from said second optical scanning device to the said surface is substantially one metre or more in length

40. A laser apparatus comprising:

a laser to emit an optical beam,

a first optical scanning device, and

a second optical scanning device,

said first optical scanning device comprising

a first platform

a first mirror provided on said first platform to reflect an optical beam incident on said first mirror,

a first pivot about which said first platform is able to pivot,

first piezoelectric actuator means to act on said first platform to pivot said first platform about said first pivot in a first direction, and

first resilient means to bias said first platform about said first pivot in a second direction opposed to said first direction, and

said second optical scanning device comprising

a second platform

a second mirror provided on said second platform to reflect the optical beam incident on said second mirror,

a second pivot about which said second platform is able to pivot,

second piezoelectric actuator means to act on said second platform to pivot said second platform about said second pivot in a third direction, and

second resilient means to bias said second platform about said second pivot in a fourth direction opposed to said third direction,

wherein said first piezoelectric actuator means acts on said first platform at a

location in proximity to said first pivot to pivot said first platform such that the angle at which said beam is reflected by said first mirror is altered to alter the path of the reflected beam to thereby scan the reflected beam in a first plane, and said second optical scanning device is arranged such that said second mirror receives said beam reflected by said first mirror and said second piezoelectric actuator means acts on said second platform at a location in proximity to said second pivot to pivot said second platform such that the angle at which said beam is reflected by said second mirror is altered to alter the path of the reflected beam to thereby scan the reflected beam in a second plane, such that said reflected beam is scannable over said surface in two dimensions to thereby scan the reflected beam over a surface to perform material processing of said surface by the reflected beam and the optical path of the reflected beam from said second optical scanning device to the said surface is substantially one metre or more in length.

41. A laser apparatus according to claim 39 or 40, characterised in that a third mirror is provided to reflect the reflected beam reflected by said second mirror prior to said reflected beam being reflected to said surface.

42. A laser apparatus according to claim 41, characterised in that a fourth mirror is provided to receive the reflected beam from said third mirror and said fourth mirror is arranged to reflect said reflected beam to said surface.

43. A method of scanning an optical beam, in at least a first plane, over a surface using an optical scanning device according to any one of claims 1 to 17, characterised in that it comprises

determining a required location for the optical beam to be incident on said surface,

determining whether a positive or negative change to the voltage applied to a said piezoelectric actuator means is required to pivot said platform to a required position corresponding to the said required location,

comparing the existing position of said platform and the voltage applied to said piezoelectric actuator means with the required position of said platform,

calculating the required voltage to be applied to said piezoelectric actuator means corresponding to the required position of said platform,

applying the said required voltage to said piezoelectric actuator means to move said platform to said required position such that the optical beam is incident on said surface at the said required location.

44. A method according to claim 43, characterised in that said required position of said platform and the corresponding required voltage to be applied to said piezoelectric actuator means are recorded for use in determining the voltage to be applied to said piezoelectric actuator means for the next location at which said optical beam is to be incident on said surface.

45. A method according to claim 43 or 44, characterised in that the steps of the method recited in claim 43 or 44 are carried out on each of the first piezoelectric actuator means and the second piezoelectric actuator means to pivot said platform to the required position for the optical beam to be incident on said surface at said required location, to thereby scan the optical beam in two planes, such that the optical beam is scannable in two dimensions over said surface.

46. A method of scanning an optical beam, in two planes, over a surface using an optical scanning apparatus according to any one of claims 18 to 32, characterised in that it comprises

determining a required location for the optical beam to be incident on said surface,

determining whether a positive or negative change to the voltage applied to each of said first piezoelectric actuator means and said second piezoelectric is required to pivot each said platform to a required position corresponding to the said required location,

comparing the existing position of each said platform and the voltage applied to said first piezoelectric actuator means and said second piezoelectric means, respectively, with the required position of each said platform,

calculating the required voltage to be applied to said first piezoelectric actuator means and said second piezoelectric means, respectively, corresponding to the required position of each respective said platform,

applying the said required voltage to said first piezoelectric actuator means and said second piezoelectric actuator means, respectively, to move each said

platform to the respective said required position such that the optical beam is incident at the said required location.

47. A method according to claim 46, characterised in that said required position of each said platform and the corresponding required voltage to be applied to said first piezoelectric actuator means and said second piezoelectric actuator means, respectively, are recorded for use in determining the voltage to be applied to said first piezoelectric actuator means and said second piezoelectric actuator means, respectively, for the next location at which said optical beam is to be incident on said surface.

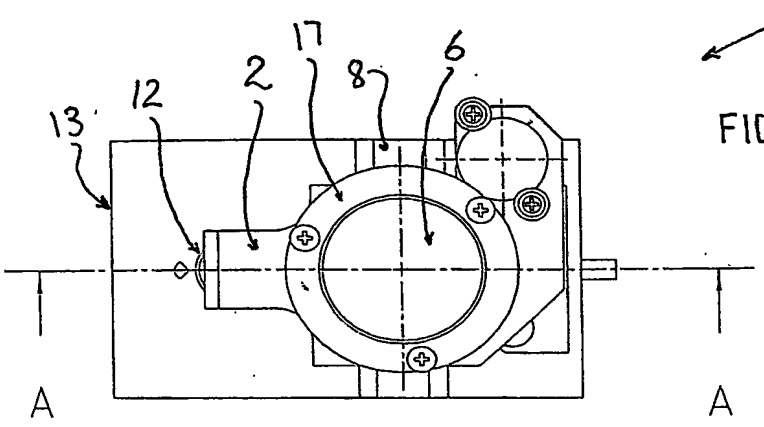


FIGURE 1a

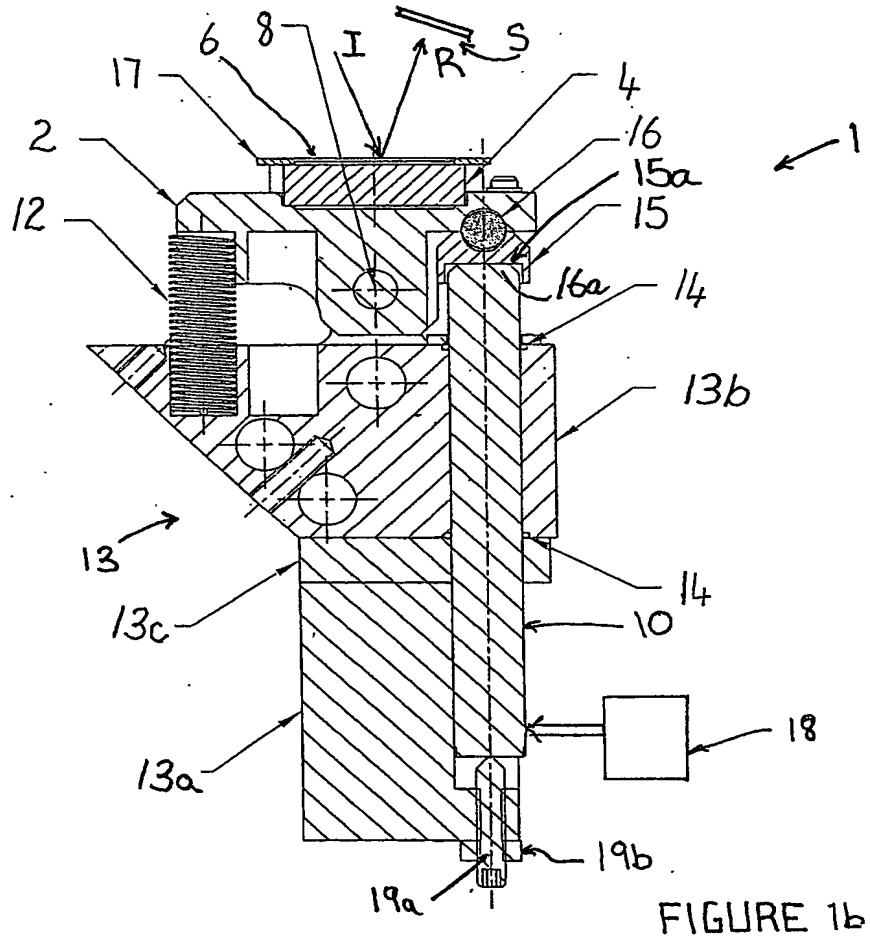


FIGURE 1b